

ABSTRACT

Methods and apparatus for monitoring the properties of a subsurface reservoir are provided. A tubular is equipped with external transmitting and/or receiving antennas configured to provide electromagnetic measurements with directed sensitivity. The tubular includes a recess formed on the outer circumference to house an antenna and electronic components, thereby reducing the tubular radial profile. A shield apparatus is mounted to the tubular to further protect the antennas mounted thereon. A tubular equipped with one or more antennas comprising a coil array, a set of saddle coils, tilted coils, or a combination thereof, provides for selective steering of the measurement sensitivity. Slots are formed on the tubular to attenuate current flow in the tubular that may result from interaction with an antenna mounted thereon. Power and/or signal data transfer between the antennas and the surface is achieved via a wireline coupled between the antennas on the tubular and the surface, or by other suitable means.

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